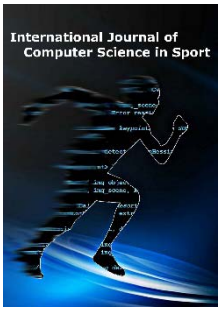
International Journal of Computer Science in Sport

Volume 17, Issue 2, 2018

Journal homepage: http://iacss.org/index.php?id=30

sciendo

DOI: 10.2478/ijcss-2018-0009



The training of soccer assistant referees beyond on-field experience: the use of the Interactive Video Test

Armenteros, M. [1], *Benítez, Anto J.* [1], *Flores, R.* [2], *Sillero-Quintana, M.* [3],*Sánchez Cid, M.* [4], *Simón, J.A.* [5]

[1]*Journalism and Audiovisual Communication Department, University Carlos III of Madrid, Madrid, Spain*

[2]*Geometry and Topology Department, University of Sevilla, Spain*

[3]*Faculty of Physical Education and Sports Sciences (INEF), Technical University of Madrid (UPM), Madrid, Spain*

[4] *Department of Communication Sciences and Sociology, Faculty of Communication Sciences, Rey Juan Carlos University, Madrid, Spain*

[5]*Faculty of Sport Sciences, Universidad Europea de Madrid, Madrid, Spain*

Abstract

The main objective of this article was to analyse whether the Interactive Video Test (IVT) is a useful tool for the practical off-field training of soccer assistant referees, and if its use could reduce erroneous on-field decisions when applying Law 11 of the Laws of the Game. Assistant referees were taken from the Spanish 2nd "B" and 3rd Divisions, and were divided into two groups, the Experimental Group (EG) and the Control Group (CG). The referees in the EG were trained with the Interactive Video Test by analysing 720 off-side decisions. Subsequently, both groups were assessed in on-field tests involving the simulation of 326 possible off-side situations. When the results of both groups were compared, there was a continuous improvement over time in the EG associated to the use of the IVT, significantly better than the improvement of the CG. Moreover, the IVT proved to be a good diagnostic tool to assess the skills of assistant referees in perceiving and evaluating off-side situations.

KEYWORDS: ASSISTANT REFEREE; FOOTBALL; DECISION-MAKING SKILLS; JUDGING OFFSIDE TRAINING; VAR

Introduction

During soccer matches, assistant referees make several decisions regarding situations that could infringe Law 11 of the Laws of the Game:

> *A player is in an offside position if any part of the head, body or feet is in the opponents' half (excluding the halfway line) and any part of the head, body or feet is nearer to the opponents' goal line than both the ball and the second-last opponent.*
>
> *The hands and arms of all players, including the goalkeepers, are not considered. A player is not in an offside position if level with the second-last opponent or last two opponents.* (International Football Association Board, 2017, p. 93)

Various studies have been carried out on the accuracy of these decisions, and on average, it is has been shown that five or six of these potential offside situations arose in each of the games in the 2002 World Cup in Korea and Japan (Helsen, Gilis & Weston, 2006).

Since these events are produced in line with the back-most outfield player on the defending team, they are often associated with a clear chance on goal. Hence, the accuracy of the decisions becomes more critical (Koch, 2008) in function of the importance of the competition, particularly given the low winning margins in such games. For example, of all the games played in the knockout stages at the 2002 FIFA World Cup (last 16, quarter-finals, semi-finals and final: a total of 16 games), nine were won by just one goal and two were won on penalties. Indeed, in the most popular competitions there is increasing public demand for better offside decisions. Given that the quality of referees' work should be beyond doubt, FIFA is constantly working to improve the training of assistant referees in order to reduce errors as much as possible (Catteeuw et al., 2010).

The assistant referee must make a snap decision whenever a possible offside occurs. Ideally, the assistant referee should be able to form a mental image of the situation and the key elements, and evaluate the resulting configuration, considering: the penultimate defender, the forwards evading their markers, the passer and the ball. Every time an attacking player touches the ball, the assistant referee should re-evaluate the position and intentions of their team-mates who might be in a position to take advantage of a possible infringement.

Although there are variables that influence on-field performance independent of the age or the experience of the assistant referee (Gilis et al., 2009; Helsen, Catteeuw & Bart, 2007), the task they are required to carry out stretches certain human capacities to the limit. Part of the assistant referee's task is to constantly redefine the precise position of the offside line. The assistant referee tends to trace the offside line from his own standpoint towards the position of the penultimate defender, whether or not this is perpendicular to the sideline. If the assistant referee is not correctly placed and the resulting line is not perpendicular, the chance of introducing errors increases (Helsen et al., 2006). If the attacking player passes between the penultimate defender and the assistant referee, and the assistant referee is nearer the goal-line, or the attacking player passes on the other side of the penultimate defender with the referee located nearer the centre of the pitch, "optical error" could turn an offside into a legitimate situation. Conversely, if the assistant referee is situated behind the offside line, towards the centre of the field, and the attacking player moves between the penultimate defender and the assistant referee, or, if the attacking player passes on the far side of the penultimate defender with the assistant referee situated nearer the goal-line, a legitimate situation could be penalised as an infringement (Helsen, et al., 2006; Oudejans et al., 2000).

These situations, with just three mobile elements (two players and the ball), can be even more complicated if the defending team works in a line defending far from their goal and the attacking team advances with several players at a time. Taking this into account, the tactics

employed during the game (Catteeuw et al., 2010) are important factors that can influence the quality of offside decision-making.

The physical ability to follow the game implies a higher than average level of fitness, given that fatigue reduces the capacity of the assistant referee to sprint and stay on the offside line (Krustrup, Mohr & Bangsbo, 2002; Mallo el al., 2008). Additionally, assistant referees require skills specific to the on-field role that they play (Catteeuw et al., 2009; Helsen et al., 2007), for example, trying to anticipate the movement of the defence to always be in the best possible position.

According to various studies, inadequate positioning on the offside line isn't the only factor contributing to erroneous decisions (Catteeuw et al., 2010; Gilis et al., 2008; Helsen et al., 2006). Indeed, what is known as "flash-lag" is considered to be the effective cause in a large number of errors when judging position. This, in fact, is a tendency in the human perceptual-cognitive system to perceive that a moving object is positioned further in its trajectory than it actually is at any given moment (Baldo, Ranvaud & Morya, 2002; Catteeuw et al., 2010). Research focusing on this effect indicates that the most complicated situations for the assistant referees to evaluate are precisely those where the attacking player and the penultimate defender are running in opposite directions, and when a pass is made at or near to the moment when they cross (Gilis et al., 2008; Helsen et al., 2006).

It has been proposed that the most common error committed by assistant referees when assessing potential offside situations is raising their flag despite the position being legitimate, known as Flag Error (FE), as opposed to not signalling an infringement (Non-Flag Error, NFE: Gillis et al., 2009; Helsen et al., 2006). This occurs despite FIFA stipulations indicating that in case of doubt the flag should not be raised (FIFA, 2009).

Offside decisions taken by assistant referees must adapt to the style of play of the teams on the field. Contrary to what may be expected, most of errors made in offside situations don't come at the end of each half due to fatigue but rather, in the first 15 minutes (Helsen et al., 2006; Mascarenhas et al., 2009). Complicating their task, assistant referees also must divide their attention to assess the precise moment of the pass, a key determinant in an offside situation. The time the assistant referee takes to focus on the penultimate defender to calculate the offside line has been calculated to be around 250 or 300 milliseconds (Sanabria et al., 1998). This minimum figure is generous for many situations on the field, given that there are many times that the player passing the ball is positioned at 70-80 degrees from the penultimate defender, and the corresponding increase in lag will result in erroneous perception of the actual on-field situation.

There are no references to the role that sound could play in the perception of offside situations by assistant referees, so this issue is not always taken into consideration. In laboratory experiments sound is not used because the replays analysed generally come from games broadcast on television, which don't usually have independent ambient sound. For example, an assistant referee that trusts in the sound produced by a pass made at a distance of 36 metres would hear that sound one tenth of a second later. In this time frame, a player setting off at $5ms^{-1}$ would have run half a metre (based on the calculation used by Sanabria et al. (1998)), and if the defender and the forward were running in opposite directions, they would be separated by one metre.

In additional to these physical and physiological variables, it would also be useful to consider a number of psychological variables such as motivation, safety, objectivity, stress and burnout in order to obtain a more complete panorama of the internal factors that could influence the correct on-field perception of offside situations (Plessner & Haar, 2006).

There is a fundamental problem when trying to improve decision-making by assistant referees in offside situations, since most of the experience obtained by assistant referees comes from the field of play. Currently, there are no alternative methods for specific training, although videos and computer animations are potentially useful tools (Armenteros, Benítez & Curca, 2010; Gilis et al., 2009; Williams, Ward & Chapman, 2002). However, it is also important to be able to give assistant referees direct information and specific training off-field (Catteeuw et al., 2009; Ericsson, Krampe & Tesch-Römer, 1993; Gilis et al., 2009). Both video and computer animation permit key elements in each replay to be examined repeatedly at different speeds, as well as allowing the level of comprehension of the laws and the precision of their application to be evaluated. Indeed, the possibility of multiple replays opens the way to participative learning for an undefined number of students (Gilis et al., 2009), and permits a high level of control over the training material, reducing both the costs and inconveniences in organisation. However, the improvement generated in laboratory learning in the tests used for training might not be reflected in improved performance in real on-field situations (Williams et al., 2002).

While it must be assumed that a perfect simulation to recreate real on-field situations still does not exist, it is necessary to determine if training using the different techniques currently available ultimately improves decision-making skills. Perhaps by recreating a simulation environment similar to that experienced by an assistant referee on the field of play, a student can exercise perceptive skills such as peripheral vision and saccadic movement (Gilis et al., 2009). However, it would be difficult to use this with a large number of students and thus, it is necessary to carry out further research to test whether this type of learning associated with such specific skills can be transferred efficiently to a real situation.

While it is difficult to control on-field tests, making them less reliable (Gilis et al., 2009), in laboratory tests the same material can be used by all the students, improving the precision of the subsequent evaluation. Given the availability of improved technology, the FIFA refereeing department has gradually leaned towards the use of new technology in the off-field training of referees and assistant referees. This training was initially limited to the use of analogue video but it now involves the use of sophisticated interactive multimedia learning materials. The instructors use interactive video, animations and simulations to improve the training and to produce officials who are better equipped for on-field decision-making. In November 2010, FIFA produced an Interactive Video Test (IVT) with nearly 200 offside situations that have been used in this research. One of the main advantages of this IVT lies is its ability to represent movement better than other media, such as fixed images, the analysis of which does not produce the same benefits in overcoming perceptive barriers like “flash-lag”. Additionally, the fact that the student has the possibility of making offside decisions and obtaining immediate feedback is an improvement on the pure analysis of the video.

In a prior study, eleven international referees from different cities around the world answered questions concerning technology, methodology and usability in order to investigate the educational benefits of this interactive resource. The results showed that the IVT tool is very easy to use (Armenteros & Benítez, 2011). However, it still remains to be seen whether the IVT tool is useful off-field in helping assistant referees to improve their perceptive skills and their ability to evaluate offside situations, and whether these skills are then transferred to on-field situations.

The benefits of using computers in the learning process as opposed to traditional methods have been established in distinct studies. Among the most relevant benefits that could help improve decision-making in offside situations through the use of the IVT are:

- Interactivity seems to produce a strong positive effect on learning (Lawrence, 1996).
- The use of computer-assisted models to support interactions within a task leads to improved individual understanding of group activities (Ulicsak, 2004).
- Learning can take place at any moment and in any place, allowing students to progress at their own pace, and permitting instructors to follow the progress of each student more easily and objectively (Lu & Chiou, 2009).
- Analysing offside situations in video images taken from an adequate viewpoint could be useful in helping refereeing officials apply Law 11 correctly (Helsen et al., 2006).
- Offside situations should be simulated with varying levels of complexity to give assistant referees better learning experiences. Training through video can offer a unique tool to help assistant referees improve their perception and their work during games (Helsen et al., 2006).

With the most significant variables and the support of computer-aided learning taken into consideration, the following hypotheses were examined:

i) The use of the IVT serves to improve the results of decisions taken by assistant referees in offside situations. ii) Learning with IVT has a positive influence on decision-making in situations of offside produced in a real on-field situation.

Methodology

Sample

Thirty-five assistant referees from 2nd Division "B" (25 participants) and 3rd Division (7 participants) categories belonging to the Federación Madrileña de Fútbol (Spain) were invited to participate in the experiment.

A pre-test was conducted using 40 offside clip from a database of 180 clips randomly selected. After analysing the results, eight assistant referees were selected on the basis of, age (mean = 25.5 yrs. ± 11.2), level of experience (mean = 4.3 ± = 7.2), the number of correct answers in the test (mean = 23.4 ± 6.7) and availability to participate in the training period. Four assistant referees made up the control group (CG) with four in the experimental group (EG).

Apparatus

All the participants were simultaneously subjected to the pre-test with the IVT tool (edited by FIFA in November 2010), randomly selecting 40 video clips of offside situations from a database of 180 clips. The clips were projected on a 190 x 142 cm screen, using a TOSHIBA 3LCD projector, model TLP-XD2000, with a resolution of 1024H x 768V, at a distance of 2.5m (row one), 3m (row two) and 3.5m (row three). The IVT is an evaluation test model in which the participants have to decide whether the clip shown was offside or not (for more details see Armenteros & Benítez, 2011). The offside situations used in the video test were recorded at a shutter speed of 1/50", at 1/25 frames-per-second and at a distance from the edge of the penalty area of approximately 3m (Figure 1). The framing was adjusted to include the passer of the ball and the defensive line. The clips were shown in a window with an aspect ratio of 1.76:1 (panoramic), covering the complete computer screen.

Procedure

After the pre-test analysis, the two groups of four participants were analysed: the control group (CG) and the experimental group (EG). The CG did not receive any training with IVT. The EG

studied six distinct random series of 40 cases over three days in a University Carlos III of Madrid research laboratory, although the availability of each assistant referee meant that each series could be studied at different times of the day. In each session, the assistant referee carried out an Interactive Video Test of 40 clips and afterwards, the videos in which they had made an incorrect decision were analysed. On finishing the training period, each assistant referee in the EG would have practised on a total of 720 (40x6x3) clips from the offside Interactive Video Test produced by FIFA in 2010 (FIFA, 2010), where clips are chosen at random from 170 offside situations of which 33% were infringements of Law 11: 87 clips from model A, 47 from model B, 25 from model C and 11 from model D.

Model A

Model B

Model C

Model D

Figure 1: Model situations included in the IVT published by FIFA (FIFA, 2010). Model A: last defender remains in his position when an attacker runs toward the goal line. Model B: both defender and attacker run and cross in opposite directions. Model C: two defenders remain in their position when one attacker passes the ball to a second attacker who tries to play the ball. Model B: three attackers pass the ball to each other and try to cross the two defenders' wall

On-Field Test

This last phase of the experiment consisted of an evaluation test of both groups of assistant referees on the four models of offside exercises identical to those used in the IVT, but with eight players from the Third Division and Madrid Regional League.

Two days after the training period with the IVT, the EG undertook a test together with the assistant referees from the CG on the pitch. In this way, one assistant referee from each group reached a decision on the same situation enacted by players (see Figure 2), permitting the decisions made to be directly compared between the two referees. The players rested after four or five replays. Each situation was observed by pairs of assistant referees (one from the CG and one from the EG), placed at either side of the axis of the camera, at a distance of around 30cm. After each situation, each assistant referee marked their decision in his notebook and

went to the back of the line, allowing the next pair to come forward (Figure 2).

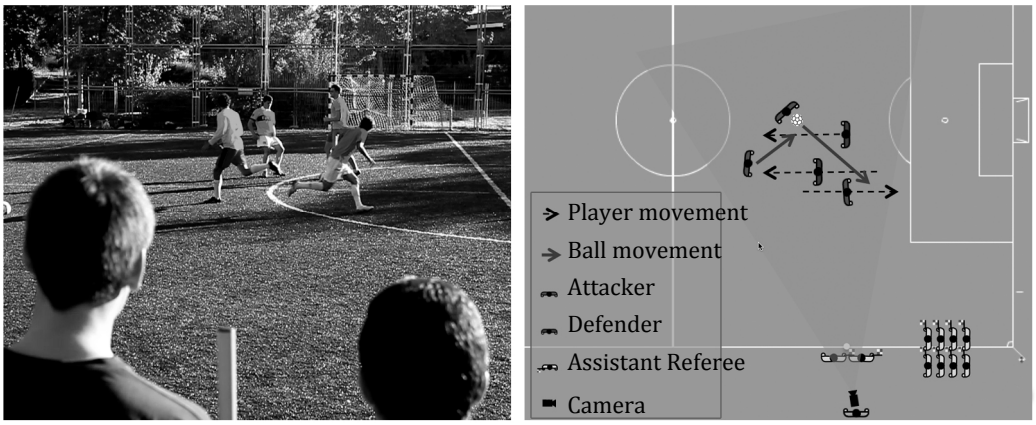


Figure 2. Positioning of the camera, assistant referees and players in the on-field test.

The players enacted a total of 336 situations: 72 according to model A, 72 according to model B, 96 according to model C and 96 according to model D. After finishing the on-field test, each pair of assistant referees had seen a total of 84 situations: 18 of model A, 18 of model B, 24 of model C and 24 of model D. The initial plan to keep the same players was to perform 48 play sessions (48:4 situations pairs = 12 per couple) per model (the proportion of play situations of each model was not considered as relevant); however, the good flowability of the repetition of plays allowed adding more plays of all the models (A, B, C and D) in the on-field test.

Statistical methods

Once the data collection was done, the Shapiro-Wilk's test was applied to verify the normal distribution of the data in order to apply parametric or non-parametric statistics. ANOVA analysis, Chi-square tests – both the classical and the paired version (the McNemar test) –, and the Mann-Whitney test were performed. All the computations were undertaken with the program SPSS IBM Statistics, version 20.0, setting the significance level at α=0.05.

Results

The effectiveness of the Interactive Video Test as a training tool

To assess the effectivity of the ITV as a training tool, the proportion of correct answers from the eight assistant referees in the sample group (four from the EG and four from the CG) in the pre-test and the on-field test were examined. Table 1 summarizes the descriptive statistics of the variable "proportion of correct answers" in the pre-test and the on-field test for the eight assistant referees who participated in the study.

Table 1 shows that the results of the EG in the on-field test were better than those obtained in the pre-test (p<0.05), with the proportion of accurate answers increasing from the pre-test (59.4%) to the field test (72.9%). However, similar significant results (p<0.05) were found for the CG with success percentages of 60.6% in the pre-test and 72.0% in the on-field test. No significant differences were found between EG and CG for both the pre-test (p=1.00) and the on-field test (p=0.77).

Additionally, even when the mean increment of success on the EG (13.5%) was slightly higher than the increment of the CG (11.4%), this difference was not significant (p=0.730). On that point, Table 1 shows how the benefits of the training with the ITV was crucial for AR4, who

had the second worst results for the pre-test (52.5%) but became the best in the on-field test (82.1%), obtaining an improvement of 29.6% in the success rate.

Table 1. Results for all the participants (ARn) for the pre-test and the on-field test (post-test) on the Experimental group (EG). n=number of trials; Δ = Improvement of the % in the on-field test compared with the pre-test.

		RIGHT PRE-TEST (n=40)	RIGHT ON-FIELD (n=84)	% RIGHT PRE- TEST	% RIGHT ON-FIELD	Δ
EG	**AR1**	27	64	67.5%	76.2%	8.7%
	AR2	23	55	57.5%	65.5%	8.0%
	AR3	24	57	60.0%	67.9%	7.9%
	AR4	21	69	52.5%	82.1%	29.6%
	AR5	26	64	65.0%	76.2%	11.2%
CG	**AR6**	22	57	55.0%	67.9%	12.9%
	AR7	19	54	47.5%	64.3%	16.8%
	AR8	30	67	75.0%	79.8%	4.8%
MEAN EG		23.8	61.3	59.4%	72.9%	13.5%
MEAN CG		24.3	60.5	60.6%	72.0%	11.4%
OVERALL		24.0	60.9	60.0%	72.5%	12.5%

The effectiveness of the training sessions

Table 2 summarizes the results of the training sessions performed by the EG along the three days of the training program.

In Table 2, it can be seen that, for all the participants of the EG, the use of the IVT produced an improvement in performance along the training process. We observe that the proportion of success for the referees significantly increased in the three days of application of the IVT, from 75.8% on the first day, to 81.9% on the second, and 83.0% on the third. An ANOVA analysis of the data from the sessions confirmed this improvement on each day (p<0.05). However, no improvement in performance along sessions on any individual day was found (Day 1, p=0.274; Day 2, p=0.814 and Day 3, p=0.700).

More errors are seen in legitimate positions (flag error)

In this experimental set-up, the incorrect/correct application of Law 11 during the training protocol of the assistant referees, was assessed. In the learning protocol with the IVT, 948 of the exhibit videos (32.92%) were offside and 1932 (67.08%) were not offside out of a total of 2880 exercises, while in the 336 simulated on-the-field situations, 22 of them were offside (6.5%) and 314 were onside (93.45%). Unexpectedly, we found that in the pre-test assessment, the proportions of NFE observed in the IVT were higher (27.9% incorrect, 72.1% correct, accuracy in offside) than the FE (15.8% and 84.2%, accuracy onside, p<0.001), in contrast to the observations in the on-field tests (NFE: 11.4% and 88.6% accuracy in offside and FE: 27.5% and 72.5% accuracy in onside; p<0.001).

Table 2. Individual and general results expressed in percentage of right decision for all the participants of the experimental group (ARn) on the training process for each day and training sessions (Sn). General and overall data as Mean±SD

Day	Referee	S1	S2	S3	S4	S5	S6	Overall
Day 1	AR1	75,0%	70,0%	75,0%	65,0%	70,0%	80,0%	72,5% ±5,2%
	AR2	70,0%	57,5%	75,0%	67,5%	75,0%	67,5%	68,8% ±6,5%
	AR3	80,0%	70,0%	77,5%	85,0%	80,0%	92,5%	80,8% ±7,5%
	AR4	75,0%	72,5%	82,5%	87,5%	85,0%	85,0%	81,3% ±6,1%
	General	75,0% ±4,1%	67,5% ±6,8%	77,5% ±3,5%	76,3% ±11,6%	77,5% ±6,5%	81,3% ±10,5%	75,8% ±8,1%
Day 2	AR1	70,0%	85,0%	80,0%	75,0%	85,0%	67,5%	77,1% ±6,0%
	AR2	85,0%	80,0%	75,0%	70,0%	70,0%	72,5%	75,4% ±5,3%
	AR3	75,0%	87,5%	90,0%	87,5%	87,5%	85,0%	85,4% ±3,7%
	AR4	90,0%	87,5%	87,5%	92,5%	95,0%	85,0%	89,6% ±2,9%
	General	80,0% ±9,1%	85,0% ±3,5%	83,1% ±6,9%	81,3% ±10,5%	84,4% ±10,5%	77,5% ±8,9%	81,9% ±8,1%
Day 3	AR1	70,0%	70,0%	62,5%	70,0%	87,5%	87,5%	72,9% ±5,2%
	AR2	67,5%	80,0%	77,5%	80,0%	80,0%	85,0%	78,3% ±2,9%
	AR3	95,0%	92,5%	80,0%	87,5%	87,5%	90,0%	88,8% ±4,2%
	AR4	95,0%	90,0%	92,5%	87,5%	92,5%	95,0%	92,1% ±4,8%
	General	81,9% ±15,2%	80,6% ±14,8%	78,1% ±12,3%	81,3% ±8,3%	86,9% ±5,2%	89,4% ±4,3%	83,0% ±10,4%

Discussion

In this study, we observed a significant improvement in performance along the training program with the IVT in the EG that was also partially evident in the on-field test. These improvements could justify the use of the IVT over three days even though the number of correct decisions in the on-field test was lower than that on the last day of the training protocol.

The fact of not finding any improvement in performance along sessions of a same day leads us to think that longer training sessions are not necessary but rather that fewer sessions per day over more days would obtain better results for the ITV.

The results in the on-field test improved in the EG when compared to the pre-test evaluation on the first day, which reflects the benefits of the training and analysis practice with the IVT tool. However, an improvement was also observed within the CG in the performance of the field test. More research should be done to explain why the participants of the CG obtained similar results in the on-field test without undergoing the six training sessions with the IVT. If one excluded the statistical outlier AR4, who extremely improved, EG even did not improve as much as CG did. This might be a result of the small sample size.

The possibility that learning took place with the IVT seems to be confirmed through conversations with some of the participants in the EG, and specifically with the assistant referee referred to as "AR1", who, at the end of the data collection, commented that in the games that he had officiated during the training period using the IVT, he had been aware that he judged the on-field situations in a different way. "Before practicing with the IVT, I looked at the general situation, now I pay closer attention to the specific positioning of the attacker and the defender". It remains a little unclear why the improvement observed during the training process in the laboratory conditions was not clearly transferred to the on-field tests. In general, learning effects cannot be excluded considering the study protocol. Although they are not identified or obvious one cannot exclude them, in particular since EG did not perform better than CG in the on-field test.

Additionally, it was observed that in the IVT a higher percentage of NFE (27.9%) was produced compared to FE (15.8%). This was reversed in the on-the-field test with more FE (27.5%) than NFE (11.4%), in agreement with previous studies (Catteeuw et al., 2010; Gillis et al., 2009; Helsen et al., 2006). This may indicate that when visualising the situations in the laboratory, the time lapse of approximately 250-300 milliseconds from when the assistant referee focuses on the penultimate defender to when they focus on the offside line is eliminated. This lapse implies that the assistant referee's perception of the position of the attacking player is erroneous, as the attacker is more advanced than was actually the case. This would confirm the theory proposed by Sanabria et al. (1998), whereby the angle that the eye covers from where the pass was made to the position of the attacking player is reduced on the computer screen.

Conclusions

The data presented confirm our initial hypothesis that *the use of the IVT improves the results of decisions taken by assistant referees in potential off-side situations*. Furthermore, in agreement with previous studies, it also seems that the number of FE is larger than that of NFE in the on-field test, while these results were inverted during the IVT training.

Further experiments will be necessary to investigate in more detail the differences in the behaviour of the assistant referees in both environments, the laboratory and training on-the-field, and to discover which variables in the IVT can be improved to produce a significant

transfer of learning to the field of play.

Acknowledgments

We would like to express our gratitude to the Technical Committee of Referees of the Royal Football Federation of Madrid, specially Enrique Ortiz and Ignacio Rubio Palomino for their ideas and their willingness to cooperate in the progress of this work.

References

Armenteros, M.; Benítez, A. J., & Curca, D. G. (2010). The trivia game as tool for learning and evaluating Football referees and assistant referees. In *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* (pp. 137-142). Chesapeake, VA: AACE.

Armenteros, M. & Benítez, A. J. (2011). La integración de Tecnología Educativa en la formación del arbitraje de fútbol de élite: el uso del "Video Test Interactivo". *Apunts. Educación Física y Deportes, 105*(3), 11-20.

Baldo, M. V. C.; Ranvaud, R. D., & Morya, E. (2002). Flag errors in soccer games: The flash-lag effect brought to real life. *Perception, 31,* 1205–1210.

Catteeuw, P., Helsen, W., Gilis, B., & Wagemans, J. (2009). Decision-making skills, role specificity, and deliberate practice in association football refereeing. *Journal of Sports Sciences, 27*(11), 1125-1136.

Catteeuw, P., Gilis, B., García-Aranda, J. M., Tresaco, F., Wagemans, J., & Helsen, W. (2010). Offside decision making in the 2002 and 2006 FIFA World Cups. *Journal of Sports Sciences, 28*(10), 1027-1032.

Ericsson, K. A.; Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, *100,* 363–406.

Fédération Internationale de Football Association FIFA (2009). Teaching Material. The Assistant Referee.

International Football Association Board (2017). Laws of the game. Zürich: The IFAB.

Fédération Internationale de Football Association (2010). Offside Interactive Video Test. Zürich: FIFA.

Gilis, B., Helsen, W., Catteeuw, P., & Wagemans, J. (2008). Offside decisions by expert assistant referees in association football: Perception and recall of spatial positions in complex dynamic events. *Journal of Experimental Psychology: Applied, 14*, 21–35.

Gilis, B., Helsen, W., Catteeuw, P., Roie, E. V., & Wagemans, J. (2009). Interpretation and application of the offside law by expert assistant referees: Perception of spatial positions in complex dynamic events on and off the field. *Journal of Sports Sciences, 27*(6), 551-553.

Helsen, W., Catteeuw, P., & Bart, G. (2007). Decision-making skills and role-specificity in football refereeing. In *Kallio, J.; Komi, P.; Komulainen, J.*, & *Avela, J. (eds.), 12th Annual Congress of the European College of Sport Science. Jyvaskyla, Finland: ECSS.*

Helsen, W., Gilis, B., & Weston, M. (2006). Errors in judging ''offside'' in association football: Test of the optical error versus the perceptual flash-lag hypothesis. *Journal of Sports Sciences, 24*(5), 521-528.

Koch, S. (2008). *Liability of Referees. An Analysis of Tort Liability for Wrong Referee Decisions (Dissertation).* Victoria University of Wellington, 2008.

Krustrup, P., Mohr, M., & Bangsbo, J. (2002). Activity profile and physiological demands of top-class soccer assistant refereeing inrelation to training status. *Journal of Sports Sciences, 20(11),* 861–871.

Lawrence, J. N. (1996). Multimedia Information and Learning. *Journal of Educational Multimedia and Hypermedia, 5*(2), 129-150.

Lu, H-P. & Chiou, M-J. (2009). The impact of individual differences on e-learning system satisfaction: A contingency approach. *British Journal of Education Technology, 41*(2), 307-323.

Mallo, J., Navarro, E., García-Aranda, J. M., Gilis, B., & Helsen, W. (2008). Analyses of the kinematical demands imposed on top-class assistant referees during competitive soccer matches. *Journal of Strength and Conditioning Research, 22(1),* 235–242.

Mascarenhas, D. R. D., Button, C., O'Hare, D., & Dicks, M. (2009). Physical Performance and Decision Making in Association Football Referees: A Naturalistic Study. *The Open Sports Sciences Journal, 2,* 1-9.

Oudejans, R. R. D., Verheijen, R., Bakker, F. C., Gerrits, J. C., Steinbrückner, M., & Beek, P. J. (2000). Errors in judging 'offside' in football. *Nature, 404,* 33.

Plessner, H., & Haar, T. (2006). Sports performance judgments from a social cognitive perspective. *Psychology of Sport and Exercise, 7*, 555–575.

Sanabria, J., Cenjor, C., Márquez, F., Gutiérrez, R., Martinez, D., & Prados-García, J. L. (1998). Oculomotor movements and football's Law 11. *The Lancet, 351*, 268.

Williams, A. M., Ward, P., & Chapman, C. (2002). Training perceptual skill in field hockey: Is there transfer from the laboratory to the field? *Research Quarterly for Exercise and Sport, 74,* 98–103.

Ulisack, M. H. (2004). "How did it know we weren't talking?": An investigation into the impact of self-assessments and feedback in a group activity. *Journal of Computer Assisted Learning, 20,* 205-211.